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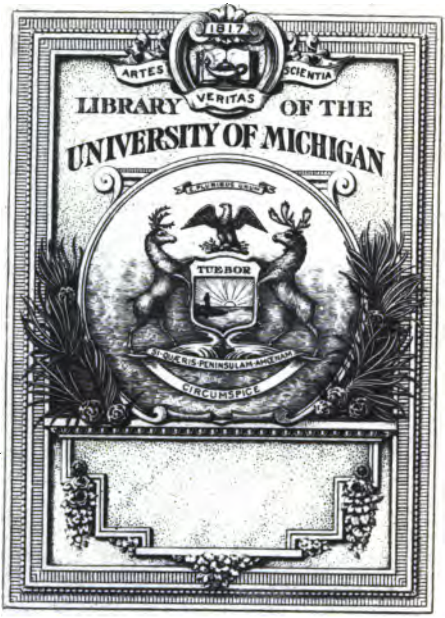

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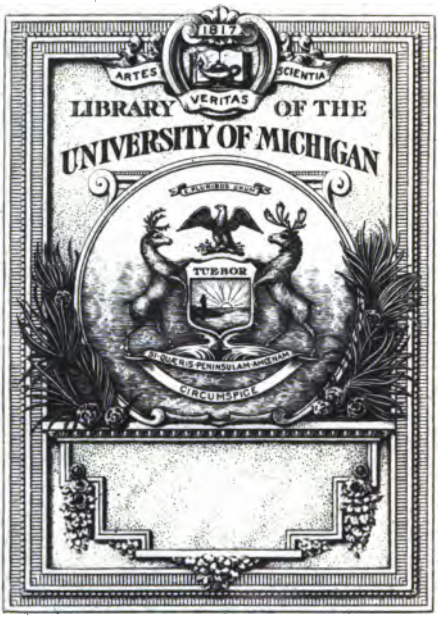

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THE

GEOLOGY OF SIDMOUTH

AND OF

South-Eastern Devon

ILLUSTRATED WITH ENGRAVINGS ON COPPER AND WOOD

BY

PETER ORLANDO HUTCHINSON

SIDMOUTH
JOHN HARVEY
1843

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PREFACE.

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Whilst writing the following pages, any available authorities were willingly consulted; amongst which may be mentioned the names of Buckland, Conybeare, Lyell, Mantell, Murchison, De la Beche, Fitton, &c. To these have been added a series of many personal observations made on different parts of the coast during a long residence in the district under consideration.

The landscape views have been inserted by way of giving an idea of the general features of the cliffs. Towards the execution of the diagrams the reader must be indulgent, for the author is only an amateur and a novice in the art of engraving on wood.

GEOLOGY OF SIDMOUTH,
&c.

As this account of the Geology of Sidmouth and the surrounding district is purposed to be of a local nature, it is not necessary to enter upon the subject generally as a science. Assuming, therefore, that our readers may already be possessed of at least some insight into its acquaintanceship, we shall mainly discuss certain geological changes which have taken place in the south-eastern part of the county of Devon, how these changes have wrought upon the external features of the country, and then direct attention to such circumstances as may be of more particular interest.

The outline of the hills is of a medium character between the extreme ruggedness of the plutonic rocks of Cornwall, and of the more recent formations ranging further eastward: for although they rise into bolder elevations than the hills of the eastern counties, still, they are of a less wild and craggy conformation than the peaks of Dartmoor.

The town of Sidmouth is situated in latitude fifty degrees forty minutes north, and longitude three degrees eleven minutes west. Lying in the bottom of a deep valley, it is protected on the east by Salcombe Hill, on the opposite side by Peak Hill and High Peak—all three of which lie on the coast and rise immediately from the sea to the height of about 500 feet: it is backed on the north by the Honiton range beyond Sidbury; on the north-west it is shut in by Bulverton, Beacon, Cor, and the Ottery Hills in the neighbourhood of Harpford Wood; and on the north-east the valley is terminated by Trow Hill, and the several others near the hamlets of Packham and Harcombe.

Although these hills rise to a considerable height, as stated, their outlines are of a smooth and undulating character, by reason that they are not composed of the primary formations, as they were once termed,—but a designation which recent experience has proved to be misplaced. The red marl and green-sand, whereof they are mostly made up, being of a friable nature, and easily yielding to the action of climate, have settled into regular slopes, and have been highly favorable to the operations of the agriculturist. The soil is deep and rich; unencumbered by stones, except the flints that lie on the greatest elevations, and which have been washed gradually into the lower grounds,—and these are never large enough to form any serious impediment to the plough. Owing to this depth of soil—which again is owing to the district being composed of a soft marl, free from rock —the roots of the largest trees find no difficulty in extending themselves in any direction, whether laterally or downwards, and hence it is, that few valleys in the county are so well stocked with a fine growth of timber. It has been remarked too—and the cause is referable to the same reason--that when heavy gales of wind have blown, the trees in this neighbourhood, instead of being deracinated, as would have been mostly the case elsewhere, have had their tops carried away, or even their thickest trunks broken off, rather than that their roots have relinquished the deep and firm hold which they had in the ground.

The new Redsandstone formation, or that which is the most abundantly developed in the cliffs, is one of the older of the stratified secondary rocks, composed of conglomerates and the detritus of such as are more ancient. At Torbay it makes its first appearance on this coast, abutting against, and resting upon the limestone, slates, and trap rocks in the vicinity of Mary Church, Babbicombe, and Torquay. It thence extends uninterruptedly in an easterly direction along the shore as far as Culverhole Point, now devastated by the recent Landslip, a distance of about thirty miles. "The Coast from Petit Tor to Culverhole Point between Seaton and Lyme Regis," observes De la Beche, "affords an excellent section of the redsandstone series, as developed in South Devon, from the lowest to the highest beds." Towards the lower parts of this formation, the debris of the older rocks of which the whole principally consists, present a coarse, gravelly, and heterogeneous appearance, mingled with fragments of every possible size, some of them being even several tons in weight; but as we ascend, these large masses are lost sight of, and are succeeded by sand more or less fine; and lastly, still higher, or in an easterly direction, by a smooth and well comminuted series of beds of clay. These beds of clay are not always of the same deep red colour: but often present seams of buff, orange, and yellow, as may be seen in cuttings on the road between Exeter and Starcross, and also on the road between Chudleigh and Newton Abbot.

In the Dawlish cliffs, near the Bishop's Parlour, there occur numerous layers of sandstone mingled with a somewhat calcareous conglomerate; and even, in a less degree, as far as Budleigh-Salterton. In the neighbourhood of the Parson and Clerk and in the Teignmouth hills, druses or cavities lined with crystals of carbonate of lime, present themselves very frequently. As we ascend in the succession of beds towards Sidmouth, a greater proportion of argil and argillaceous matter begins to abound, and not always maintaining the same uniformity of red colour, such as we have remarked as existing about Exeter, Starcross, &c.

Detached masses of a fine white sandstone--but sometimes so soft as to crumble away with ease in the hand--are at times laid bare in the escarpments of the Sidmouth cliffs, either by the action of the rains coursing down their sides, or by the abrasion of the sea at their bases. This sand is collected by the poor inhabitants of the town, and is used for whitening kitchen floors, hearths, steps, and such like economical purposes. At the top of the road that leads from the limekilns to the shore there was formerly a pit which has since been worked out: after that, another, down on the beach immediately beneath the limekilns, and probably a continuation of the same vein--a vein which still proves prolific: and there is likewise a stratum of the same sand just beyond the mouth of the river Sid. This appears to be composed of nearly the same siliceous particles as the strata between which it lies; only that not having been deposited at the same time with the other, it has escaped being coloured with the oxide of iron--and thus it is white instead of red.

It is evident from careful examination, that the great stratum of the poikilitic series* is much thicker taken through a southern section along the coast between Babbicombe on the west, and the Landslip on the east, than it is taken through a northern section in the direction of the Quantock Hills. The conglomerate also, composed of coarse fragments of the older rocks cemented for the most part with magnesio-calcareous matter, constituting its lower portion, is much more abundant to the south than to the north: and hence we may rationally conclude, that the trough into which the whole liquid was poured, and in which the precipitation of the particles held in solution occurred, was deeper toward the former direction than it

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*The New Red Sandstone Group has been named the *poikilitic* series, from ποικιλος, *poikilos*, varied: because Werner, with whom it originated, had remarked the stripes of light blue, green, yellow, or buff which ran through it—even as we have mentioned above.

was toward the latter. This conglomerate is scarcely to be dwelt on as existing in the neighbourhood of the Bristol Channel; but instead of it the more arenaceous beds are found, resembling those in the cliffs ranging along the coast near Sidmouth, and crowned by clay, like the Dunscombe and Branscombe hills, where it is seen underlying the green sand. If we suppose that the whole deposit was going on at one and the same time--that is, continuously and uninterruptedly, however long that time may have been--it should appear, that when the grau-waké and trap fragments and pebbles of the conglomerate, together with the arenaceous and argillaceous particles were in a state of settlement and subsidence, the former, being of greater specific gravity, would the soonest reach the bottom of the trough or basin, and when there, would drift towards the lowest part of that bottom southward, not being level, leaving the higher part for the more comminuted matter to settle on afterwards. In this way we may account for the different thickness of the stratum, for the appearance of the conglomerate near Teignmouth and Dawlish, and for the prevalence of the finer sand and clay at Sidmouth and Branscombe.

"The prevalence of a particular kind of rock," observes De la Beche, when speaking of this formation, "such as the rothliegendes,* the lowest member of the red sandstone group, over a considerable area, often remarkable for containing fragments of pre-existing rocks of such size as to constitute a conglomerate, is certainly exceedingly striking, particularly when it is observed that fragments of porpheries are abundant in many places. In Devon the porphery is found imbedded in the sandstones in fragments which even attain a size equal to three or four tons in weight. We will not here repeat what we have elsewhere stated [*Geological Manual, p.* 362.] respecting the evidence of violent disruption in that part of England, further than to point out that the coast between Babbicombe and Dawlish affords excellent opportunities for studying it."

It may be noted that the whole range of cliffs from Babbicombe along the shore as far as the Landslip, presents a perpendicular face; and hence may be well examined from the water with great facility in fine weather, and

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*The Lower New Red Sandstone, associating with the Magnesian Limestone, has obtained the name of Rothliegendes in Thuringia, where it is very abundant. It is interposed between the Zechstein and the Coal; and in England occupies a place between the Magnesian Limestone and the Coal. Its local designation of Rothliegendes, *red-lyer*, or Roth-todt-liegendes, *red-dead-lyer*, was given to it by the workmen in the German mines from its peculiar and deep red colour.

the dip or junction of the different strata easily traced.

It is remarkable that this formation contains no organic remains in this country as a general rule, although the two strata between which it lies, namely the magnesian limestone beneath it, and the blue lias above, are profusely charged with creatures. No vegetable or animal traces have been detected whatever, except a few pieces of petrified wood and fish scales in the upper marly strata near the Landslip, about fourteen miles east of Sidmouth approaching to the lias; and indications of certain saurians, as the Palæosaurus and the Thecodontosaurus, which have been found near Durdham Down not far from Bristol, occurring in the magnesio-calcareous conglomerate of the lower beds. These saurians are allied to the Iguana and Monitor, being the oldest examples of fossil reptiles that have been met with in Great Britain. The Zechstein of Germany is also the oldest rock on the continent in which Saurian remains have been found. They are referred to a genus called Protorosaurus, also allied to the Monitor. These instances seem to be exceptions to the general and more prevailing fact. As, throughout this country, the same thing has been constantly observed, geologists have not omitted to investigate the probable cause. According to De la

Beche, who mentions it, we are led to adopt the idea that the solution, being of a chemical nature, was, in itself, noxious to animal life. However this be, it is a question deserving enquiry: and that there must have been some positive reason for it, since the indications are marked so definedly, there can be no reasonable question. From the presence of gypsum beds, occurring in many places, it is conceived that chemical precipitation was the process to which they owe their origin; and from the appearance of red oxide of manganese and peroxide of iron, to which this red colour is owing, it is concluded that animal existence could not have been supported in the waters wherein these particles of sand and marl were suspended previously to their deposition. Now, in the clay of the lias, the peroxide, whether in a state of solution or of precipitation, no longer appears: the beds change from a red to a buff colour, yellow, and other light hues, and merge into a calcareous, indurated mud, at once displaying a fitness for animal life--and hence the abundant accumulation of organic individuals.

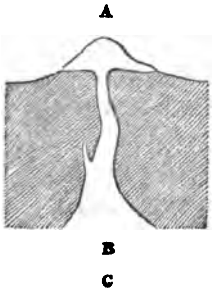
Although as stated above, this extensive formation is devoid of fossils in England, and had, until lately, been supposed to have been uniformly so elsewhere, yet a member of it, termed the muschelkalk, has been discovered on the continent of Europe, to which this general rule does not apply. In speaking of the belief that this series was thus destitute, and had always been considered so, and that it was deposited under circumstances unfavourable to animal existence, we have the following remarks in the Researches into Theoretical Geology:--"It subsequently appeared that this had not been the case; for a remarkable calcareous rock, the muschelkalk, found in the upper part of the red sandstone group in parts of western Europe, extending from Poland to the Mediterranean coast of France, contains the remains of creatures differing generally from those both in the lias and the magnesian limestone. Hence the different animals and plants, known to have existed from their remains found in the two latter rocks did not immediately succeed each other in the European area. Others of a different kind flourished at an intermediate period, and, either did not live over that part of the area, where England now rises above the surface of the sea, or there was something in the circumstances connected with the deposit itself, in the same situation, which did not permit the preservation of any part of their remains."

The muschelkalk has no where been detected in this country, although the beds on the continent are pretty extensive; and with the absence of this rock, we have also an absence of the above alluded to creatures;--"a proof," as Dr. Mantell observes, "that the strata were accumulated under circumstances unfavourable to the preservation of animals and vegetables."

The upper members of the New Red system, towards their approach to the Lias, are those in which rock salt and salt springs frequently occur: and for this reason, Murchison has applied the term "Saliferous marl and sandstone' to them. A few traces only of fossil shells, plants, or fish have been detected in them on the South Devon coast, or indeed, any where in England, although in Germany, many organic remains have been found in similarly placed beds of red sandstone and marl, especially where they become associated with the before-mentioned muschelkalk or "shelly limestone" as it has been termed. The fossil Flora of Germany which supplies the chasm in England, principally consists of ferns, extinct coniferæ of the genus Voltzia, a gigantic species of Equisetum, and of certain Cycadeæ. Amongst the shells are Cephalopoda, and Ammonites of a peculiar conformation; and such bivalves as *Posidonia keuperina*, (the *Posidonomya minuta* of Bronn) and the *Avicula socialis.* The Muschelkalk likewise produces encrinites, a few decapod crustacea, the teeth of cartilaginous fish, and several genera of extinct reptiles, as *Phytosaurus*, *Dracosaurus*, &c.

It has been remarked above, that the whole of the poikilitic group is composed of the detritus of the older volcanic rocks: there are also dykes of the same igneous origin, but of more recent date, in different parts of the county, where they may be observed as having burst up in a lava stream from the interior of the earth's crust to the surface. The conical elevation which forms Northernhay, and on which the castle of Exeter stands, is one mass of volcanic matter, at some remote period ejected from beneath, in the same manner that hot lava is cast up from the craters of Etna or Vesuvius in the present day. An examination of the oldest walls that remain of the original structure, gives good examples of the dark-brown vesicular siliceo-felsparthic compound of the igneous hill.

Fig. 1.

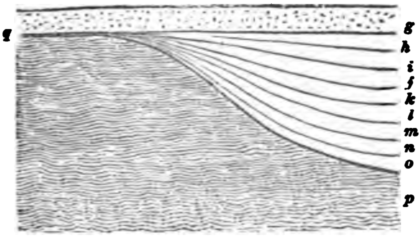


In the foregoing ideal section, the hill A is not of the same nature as that of the surrounding district, which is here represented as shaded; but is composed of lava which has burst through the shaft B from the interior, and has then, whilst in a fluid state overspread a portion of the upper surface. A fair view of Northernhay hill was exhibited a few years ago when the new Tiverton road was cut. A short distance to the south of the city there are masses of similar rock, now quarried for building stone; and at Posbury Hill near Crediton, as well as at other places, the stream has apparently flowed upwards like a cylindrical column, and seems, by excavating round it, to descend perpendicularly into the earth in the form of the trunk of a tree, as if filling up a former crater of some extinct volcano.

We will now leave the subject of the New Red series, and discuss the strata which lie upon it, only recurring to the former as occasion may require, and especially when we have to mention that somewhat extraordinary depression therein at Beer Head, six miles east along the coast, which is filled up with the lower members of the cretaceous group.

Incumbent on the Poikilos beds at Sidmouth, we have the Green Sand formation, instead of the Lias, which, according to regular geological succession, we ought to have had. Several formations are thus altogether wanting, which should have intervened between these two, here presenting themselves in juxtaposition: as such facts however, are of constant occurrence, and are to be easily accounted for, and are consequently familiar to every practical geologist, it is not considered imperative to enter upon any lengthened observations on them here any more than to refer to the following diagram.

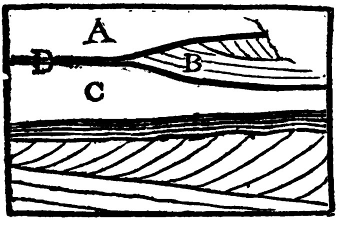
Fig. 2.



We have only to suppose that this represents the vertical section of part of a basin formed of red marl, the upper rim of which is at *q*, and the bottom at *p:* and that the various different strata *h*, *i*, *j*, *k*, *l*, *m*, *n*, *o*, have been drifted and deposited in it through the agency of water, at distinct and successive times, until it was filled up even with the aforesaid upper rim. These strata would naturally be thicker at the bottom *p*, than at the rim *q* by reason of their specific gravity; and hence the final effect would be, a level surface from *q* to *g*. After this was completed, we have only to imagine that a subsequent body of water, holding the particles of greensand in suspension, passed over the whole and deposited the stratum *q*, *g*. At the point *q* therefore, the greensand and the red marl are in contact, whilst the usually intervening beds *h*, *i*, *j*, *k*, *l*, *m*, *n*, *o*, are entirely wanting at this particular spot.

This is exemplified in the following diagram, (*Fig.* 3,) which represents a section copied from the cliff at about a mile west of Sidmouth under High Peak, where it may be seen in the first small cove formed by two projecting points of the hill. As these water marks here shewn in profile basset out on the exposed perpendicular face, and as they are not much elevated from the beach above the spectator's height, there is no difficulty in examining them.

Fig. 3.



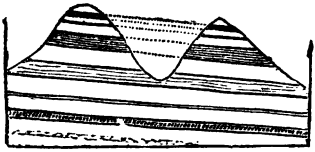
It will be here observed, that the stratum B is interposed between the two strata A and C; and that at the point D these latter come together in the same way as we have mentioned respecting those in the former example which meet at *q*. Such water marks are less apparent on the Salcombe side af the town, for the more nearly we approach the upper beds of the marl, the more fine, smooth, uniform, and indivisible into layers do they appear.

The Greensand is here very well developed, and may be examined by the curious student with every facility. Its components of silicate of iron, agreeing in composition with chlorite, which give colour to the green grains, and thence to the whole formation, are very abundant in many of the seams which crop out on the declivities of the hills, and more particularly on the steep faces which point towards the sea. The sea front of Salcombe Hill may be easily examined by ascending near the summit on the Sidmouth side, and then taking the narrow path out over. Here the strata exhibit themselves without obstruction; the harder beds projecting beyond the softer, which have yielded to the effects of atmosphere, and profusely charged with organic remains. Towards the upper beds the green grains become less frequent, the composition is almost entirely that of sand and sandy marl, abounding in masses of chert, sometimes of great size, and the green colour, so strong beneath, merges into yellow. The inferior strata, resting immediately upon the red marl, do not partake of its clayey appearance so much as in some parts of England, but the junction between the two, is decided and well defined,--the red marl maintaining its ruddy hue in all its intensity, and the Gault (as the lower Greensand is sometimes called) shewing its pure sandiness unmixed with clay quite up to the line of contact. It is the middle beds however, that are mostly green, and of the hardest nature: both the upper and lower are more arenaceous, friable, and yellow or buff coloured. Thus they do not pass gradually from one into the other, but the dividing line is well marked, whether by the character, the tint, or the composition. Although in some districts the lower Greensand below the Gault is formed partly of green and partly of ferruginous grit and sandstone, and also with an admixture of limestone, this is not the case here--at least, on the escarpments of these cliffs, where the finest section in the district is of course to be found.

From the one resting conformably upon the other, we infer that no disruption in the substrata had taken place between the period of the deposition of the New Red series, and of the deposition of the Gault upon it: and from the fact of their being so distinct and so unmixed, even where they are in juxtaposition, we may further infer, that the body of water in which they had been suspended, was at the time perfectly clear and unsullied: that the marl had wholly settled to the bottom before the precipitation of the greensand had commenced, thus leaving the water clear as we said, and that then the greensand was precipitated upon it;--and furthermore, that this vast ocean must have been in a state of quietude, otherwise the joining line would not have been so well shewn as it is, but would have exhibited a mixture of both formations.

The hills are all capped with patches of chalk or with amorphous pieces of flint and chert imbedded in a tenacious and clammy yellow clay. The chalk however, does not become well developed until we proceed a few miles further eastward: and the capping of clay and flint may here be considered as the debris of the supracretaceous groups, which once existed in a more perfect state than now. Outlying, or isolated patches of greensand, even sometimes associated with the lowest of the Tertiary rocks, are found on the summits of most of the principal elevations ranging to the westward. Thus, they occupy the top of Black Hill near Exmouth, ten miles west, and the top of the Haldon range, fifteen miles distant, whilst valleys or low hills spread over the interval, in which no such traces are visible. In the neighbourhood of Newton Bushel also, similar indications present themselves, and in this case in the low ground; and there is an extraordinary detached portion lying a few miles to the south of the town of Bideford. This remote patch has deservedly attracted attention from the situation on which it stands, and the conviction which that situation necessarily induces: it is no less than thirty-six miles from Haldon, and forty-three from Blackdown, and is particularly remarkable in a geological point of view, as tending to prove that the whole of the interval between it and eastern Devonshire was at one time entirely filled up with a regular and continuous stratum, though it has now totally disappeared, and the red marl, on which it rested, laid bare. It is scarcely possible to form any conception of how vast a quantity of detritus has been degraded and swept away from the surface of nearly the whole of this county: and a consideration of this fact, so undeniable from the evidence laid before us, will convince every reflecting mind that immense changes in the physical features of the surface of the earth may be effected, not by the sudden and violent convulsions of the volcano and the earthquake, but by the gradual denuding agency of water. The same appearances lead us to conclude that the valley in the bottom of which the town of Sidmouth is situated, is of recent formation as compared with the hills by which it is surrounded:--or in other words, that this valley did not at one time exist at all, but that the summits of Peak and Salcombe Hills were united so as to form a level plain. Mr. Nash, in his Essay on the Medical Topography of Cheltenham, printed in the Transactions of the Medical Society, gives it as his opinion, that the whole of the extensive valley of the Severn, has been thus hollowed out by some such mighty force of denudation; and compared with this, the excavation of the valley of the Sid and its tributaries which rise in the Honiton range of hills, is a mere nothing. This may be extended also to the sources of the river Sid, filling up the valleys of Packham, Harcombe, Lincombe, and the numerous others through which the minor tributaries of the river flow. All these valleys are both deep and wide: Peak and Salcombe Hills are each about five hundred feet high, above the level of the sea; and the distance, as the crow flies, from the summit of one to that of the other, may be nearly two miles; hence the mass of matter which filled this gulf up to a level with their highest points, as well as that filling the others, must have been immensely great; yet we have every reason for believing that these are of artificial and comparatively recent formation. When we find two elevations standing near each other, both composed of horizontal strata or nearly so, and those strata presenting similar component materials, lying in regular order and succession one above another, the natural conclusion is, that they were both made at one and the same time, by the same influences; and that whereas there is now an interval or gap between them, that interval was effected by the removal of the soil, and not from the building up of the elevations independently of each other.

Fig. 4.

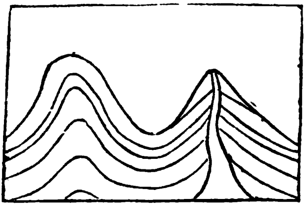


Section of two hills that were evidently united at some former period;—as shewn by the direction of the strata.

This does not go to argue that all hills and mountains whatever, lying contiguous to each other, must be supposed to have been once similarly united. We do often see mountains standing near together which were never united:

others we see which could not so stand unless they had been joined at some remote and unknown period. To volcanic agency, and confined gasses expanding, and endeavouring to escape through the surface, we must look, to account for local phenomena such as will tend to throw up detached cones; but not for the process of excavating valleys out of stratified and horizontal deposits, containing clay, or sand, the detritus of other and harder rocks.

Fig. 5.



Section of two hills that never were united;—as shewn by the course of the strata.

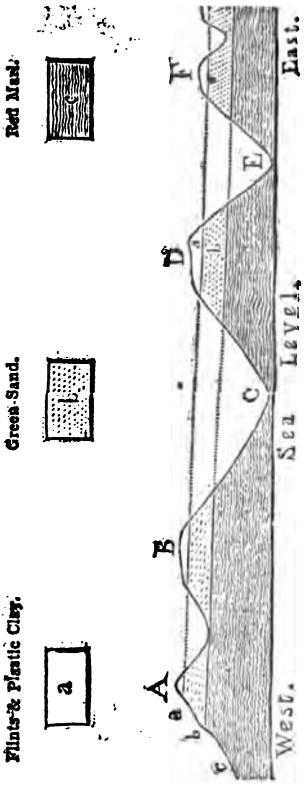
That the red sandstone and greensand series were formed of the sediment precipitated to the bottom of an immense body of water, in which that sediment had been held in suspension, is evident from their structure and the fossils they contain; and that they were afterwards, by some internal convulsion, raised above the height we now see them, follows in course:

this may have been effected suddenly, although the absence of great faults and disruptions does not invite that opinion; or it may have been brought about by slow and imperceptible degrees, like the gradual upraising of the north of Scandinavia, the south of the American continent, or the sinkings of the shores of Greenland,—processes, as geologists are well aware, which are going on at the present time. The line of junction between these two strata at Sidmouth is very clearly defined on the escarpment of Salcombe Hill as we have said: it is very straight, it dips to the eastward only a few degrees beneath the horizontal, and runs through all the neighbouring hills in a corresponding manner.

This will direct us to the origin of these local features, and the causes to which they owe their present appearance, as we shall treat of in its proper place.

The accompanying diagram exhibits the Sidmouth cliffs as looked at from the sea: it shews the different strata lying one above another—how exactly these strata correspond with each other on the summit of every hill—and how plain it is that all these detached portions must at one period have been united, before the several chasms were excavated.

Fig. 6.



A. High Peak Hill.
B. Peak Hill.
C. Valley of Sidmouth.
D. Salcombe Hill.
E. Salcombe Mouth.
F. Dunscombe Hill.

Section of the Sidmouth Hills facing the sea.

The dotted lines carried from one height to another, mark the continuation of the strata, shewing how they existed before the valleys were excavated; and it will be readily perceived how exactly the chalk, greensand, and red marl severally match each other in position from one hill to the other. A consideration of this one fact will immediately convince any person, even having no geological knowledge, that these elevations owe their existence, not to having been heaped up by some convulsion in separate and detached masses, but that they were made by excavating the valleys out of a high range of stratified land. The tops of all these hills are flat or nearly so, and of equal elevation with small variations; so that when standing on Peak Hill for instance, and looking either in a northerly or easterly direction, it is nearly like looking over a plain, as the sunk valleys thus artificially made, are almost imperceptible. We conceive that the two streams here discharging themselves into the sea, namely, Wolbrook on the west, and the river Sid on the east of the town, fully sufficient in themselves to have degraded and carried the soft and yielding soil away, mingled with their waters into the common receptacle into which they fall, and thus to have made the valley in which Sidmouth, Sidford, and Sidbury stand. That an immense period must be allotted to the accomplishment of such a work is beyond question: yet geology teaches us to look upon geological periods, as portions of immeasurable duration, exceeded only by the more enduring lapse of eternity. A very little is enough to commence the work:—the drainage of a small slope will make a gutter; and in a friable soil, that slight drainage will work a chasm, which every shower deepens. Such a gutter may have been the commencement of the present valley of the Sid; and at that time it may have trickled along over the top of the then high land, running in the direction, and perpendicularly over what is now the river. Although no human life is long enough to bear witness to the slow advance of such a fact, it must not be denied that such a fact cannot be--at least whilst we have convincing geological testimony to the contrary. When we look at the smallness of the stream, and then at the width and depth of the valley through which it runs, we might, by the first impulse, be disposed to question whether, of itself, it could have been enough to have produced such an effect: yet, a little consideration on this point will serve to satisfy us that the idea is not without reason, and will admit of rational argument. In seasons of drought there is scarcely water to be found in it adequate to turn the neighbouring mill: but throughout the greater part of the winter, and often in the summer, its size increases tenfold, and it rushes with a violence and volume incredible to those who have seen it only when nearly dry. At these times it is of a foul muddy colour; and on dipping a tumbler-full out of it and allowing it to stand awhile, a thick sediment will be observed on the bottom and sides of the glass. Whence then comes that sediment? What is it? Why it is a portion of those hills which rise to the height of 500 feet on each side of the river:--a portion which the rain washed down their flanks when it fell on them and descended to the lower grounds. This slight sediment, made up of merely a few grains of sand and a little clay, is but insignificant certainly by comparison: but when we bear in mind that we take up this in one instant of time--that we dip up but a single pint of water,--that the river, now full to overflowing, is from its sources to its mouth, in every innumerable pint of its contents, equally impregnated with earthy matter--that it continues to run in this muddy state at intervals for days and even for weeks together in the year--that these floods during the winter usually continue with little intermission, and frequently occur in the summer--and lastly, that they have not only happened through the past year, but probably through the course and continuance of many centuries--we may then conceive some idea of the effects that may be produced, and the changes brought about, by causes at first sight taken to be insignificant, trifling, and wholly inadequate to such a work.

After the above was written, we experienced some satisfaction in meeting with a similar train of argument in De la Beche's Geology of Cornwall, Devon and Somerset, a work which at that time we had not seen. It is so entirely corroborative of what is advanced above on the power of running water to excavate valleys, that, as a satisfaction to the reader and in justice to ourselves, we cannot resist recurring to it in this place.

"During every rain over the district," he observes, "there is a general movement of the particles composing a large portion of its surface, from their previous places to lower levels. The amount moved may be comparatively insignificant during a year or a century, but the cubic contents of that which descends to lower grounds during the lapse of a great geological period, must be very considerable. True it is that when we collect the foul waters of a flooded river and examine them, we are frequently surprised at the small quantity of sediment thus obtained in a cubic foot of water, even when they appear much coloured by it. Few persons however, can have watched the various rivers of the district discharging themselves into the sea, without perceiving that collectively, a large body of detritus in mechanical suspension, is annually transferred from the dry land into it. If we even suppose that every square mile in the district merely furnishes upon an average, one cubic foot of fine detritus daily to the drainage waters, we should have 1,719,880 cubic feet, or taking 15 cubic feet to the ton, 114,660 tons of fine sedementary matter annually thrown into them, independently of gravels of various sizes." In this estimate of one cubic foot of detritus given daily to each square mile of surface—a calculation sufficiently low to come within the verge of every probability—we have 114,660 tons annually, supposing this goes on every day alike. With regard to the Sid, the floods are only occasional as we have before remarked; and if we were to endeavour to make a calculation with regard to this river, we must take but a small portion of the year in which it is turbid --say one fourth. We may also perhaps say that itself and its numerous small tributaries are fed by a drainage of little less than twenty square miles of surface--that is, taking in the southern declivities of Honiton Hill, the hills ranging round Lincombe, Harcombe, Packham, as well as Peak and Salcombe hills; the rains descending on all which are carried off by this one outlet alone, and the smaller stream of Wolbrook. Assuming these data to be sufficiently correct, we find that 1820 cubic feet, or taking 15 cubic feet to the ton as above, that no less than 121 tons of earth and sand are every year washed away from the valley of Sidmouth, and carried out into the sea.

Different writers have made very dissimilar estimates as to the quantity of detritus held in solution by various rivers:--Sir George Stanton calculated that the Yellow River in China contained one part in 200 of its volume:--Hartsoeker thought the Rhine held one in 100 in suspension: but Mr. Leonard Horner says that this is a great deal too much, and that one in 1600 would have been nearer the truth with regard to this stream. Manfredi supposed from calculation, the average quantum of mud was $\frac{1}{175}$ of the volume of all the rivers falling into the sea all over the world: Mr. Rennie inferred that the Ganges contained one fourth its capacity of earthy matter: but on this statement Lyell remarks--"There must certainly be some mistake, perhaps a misprint in the Philosophical Transactions: and some have conjectured that the learned hydrographer meant one in 400 of mud." The Ganges discharges every year into the sea 6,368,770,440 cubic feet of solid matter along with its waters; which would be about equal to 355,361,464 tons weight, or as much as sixty Great Pyramids of Egypt:--or again, as much as 2000 ships of 1400 tons burden daily sailing down the river, could carry away in the year, if freighted with this earth so discharged!

Taking the above data to be correct--and they are collected from persons of acknowledged learning and experience--and allowing only one fourth of the year for a flooded state of the Sid, that it is the outlet of the drainage of twenty square miles of country, we find that this small river carries along with it into the sea 121 tons of solid earth every year. Now, such an assertion, unaided by calculation would be incredible: but as it is the result of due consideration, we may rest satisfied to assume it as a truth. Such a process of abrasion and removal, although greater now than when it commenced, thus allowed to be going on, will go far to convince the sceptical that this valley owes its existence to the wasting power of water alone. To the same influence may be ascribed the formation of most of the wide valleys in different parts of England and every where else, not only on the eastern side of the country among the newer strata, but also even among the older rocks on the west. The commencement of the making of a like valley may be observed at Salcombe and at Slade, where a small stream trickles down to the sea from the high ground, commencing with nothing, but widening and deepening as it proceeds. Speaking of the wasting power of water, De la Beche observes, that most of the immense valleys that extend between the elevated parts of the Alps, were probably for the most part worn into their present vastness by the mountain torrents which rush through them. "Moving water," he says, "is the only agent known to us capable of carrying away this great collective mass of rock. In order therefore, to form a just conception of the time and conditions required to produce the effects observed, we should carefully examine the latter, and estimate the transporting powers of those running waters which now exist among the mountains themselves, and which transport detrital matter from the central parts outwards."* The tendency of a river running through a gorge, is to cut perpendicularly downwards, and not so much at the sides; hence, in rocky districts we see streams pouring through deep and narrow channels; but where the nature of the soil is soft and yielding, as in the red marl, the river no sooner carries away some portion of its bed, than the earthy sides fall in, not having tenacity enough to form steep banks; and the earth so fallen in, is immediately swept away by the water. This process therefore, will soon tend to open a wide valley, whose sides will ascend from each bank by gently elevating slopes.

Formerly an estuary or arm of the sea, having the form of a delta, existed at the embouchure of the Sid; but it subsequently became filled up with silt and gravel. The eastern portion of the town bears the name of "The Marsh," illustrative of the features of the district on which it was built; and the rest of the original marshy delta not occupied by houses, is a low meadow skirted by the river. It will be remarked that all the rivers in this neighbourhood to the distance of some miles, disembogue in the same manner, that is, that they are bounded on their right banks by a low flat tract, and that their left is bounded by the rising cliff: as witness the Otter at Budleigh Salterton, whose right bank is bounded by a flat expanse like "the marsh" at Sidmouth: the Exe, whose right bank is occupied by the warren: and at Seaton, the Axe, where a great extent of meadow lies along its margin in the same way, whilst they are all bounded on their left banks by high land and rising hills. This fact is accounted for by the prevalence of the westerly winds so generally blowing on this coast, which is ever driving the breakers on the beach in a slanting direction, instead of point blank, or at right angles to its range: and thus, the sand and shingle being obliquely wafted, tends to accumulate on the western side of these deltas, forcing the rivers to the hills on the east, where they escape by narrow channels into the sea. Hence doubtless, much change has taken place in the littoral features of south-eastern Devonshire;

and so great is the power of these apparently impotent streams to produce remarkable changes, some of which the reader has been made acquainted with in describing the excavation of valleys, that they will sometimes bring about considerable geological alterations, either by the transfer of drift matter, from the inland districts where they take their rise, down to the sea, or the formation of bars and shoals at their mouths, composed of such drift matter, often vegetable, together with sand, pebbles, silt, shells, or other such materials, being on the other hand, of marine production. Either to the transporting power of fresh water, carrying down vegetable matter from remote districts to the sea, or to the encroachment of the latter upon the land, we must look for an elucidation of the fact, that traces of a submarine forest are discoverable at the mouth of the Char near Lyme. This forest rests upon the lias; and embedded along with the trunks and roots of the trees of which it is composed, the bones of the fossil elephant (E. primigenius) have been found. We are not aware that any similar discovery has been made at the outlets of the other south Devon rivers; although the same thing has shewn itself at Torbay at low water. That the advance of the sea upon this coast has been very great, and is still rapidly going on, admits of no question; for it is not only proved by geological appearances, but also by the testimony of living witnesses. On this fact De la Beche remarks in the following words:—"Much loss of coast is sustained," says he, "near Sidmouth; particularly in the direction of High Peak, the small greensand cap on the top of which will disappear at no distant date, geologically speaking, and be only known to have existed from the geological maps now constructed of that part of the country." This is perfectly true; and every winter the soft soil yields both to the rains above, which bring down vast quantities, sometimes only by washing, but frequently by causing it to fall in masses of many tons weight at a time, and also on the other hand, by the action of the waves beneath, which in many places beat against the bases of the cliffs. So great has been the destruction on the western side of the town, that we are told it is within the memory of man when cultivated fields extended outside the limekilns, over the present sunken reef, uncovered only at low water, and known by the name of "The Chit Rocks." The Chit Rocks formed the basis of that land so cultivated; and the last standing remnant of that land, was an irregular mass situated on the reef at some score yards from the beach, surrounded by water at high tide: this mass, picturesque to the eye as an object, and serving the fishermen on the coast as a useful landmark, went by the name of

"Chit Rock." It was undermined and thrown down in the night of the 22nd. of November 1824, during the violence of a storm which devastated many parts of Great Britain. At no very distant period the limekilns will fall into the sea; for we can testify as to the encroachment that has taken place at this point during the last fifteen years. There is a cavern running into the cliff immediately beneath them, which the waves and the winds yearly increase in size and depth; and the road-way leading down from the kilns to the beach is constantly falling away, and then being cut further back. These limekilns, which now jut out as a promontory, scarcely projected from the line of cliff fifteen years ago. The same destructive causes have rendered it several times necessary to remove the road further back which leads over Peak Hill to Exmouth: and another removal still further inland must again take place before long.* Immediately opposite the town the bottom of the sea is sandy outside the shingly beach, and increases in depth with tolerable regularity: the following are found to be the soundings:—it attains the depth of 10 fathoms at 2 miles off—15 fathoms at 5 miles--20 fathoms at about 14 miles--and 30 fathoms at the distance of about 23 miles from the land: and this is taken in a direction south-easterly from the church.

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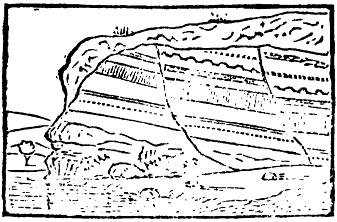
*Such a fall of cliff is locally termed a "*rusement:*" and the verb *to ruse* also obtains in the neighbourhood. The letter *u* in these words has not the open sound of *oo*, but rather resembles the French liquid *u*, amongst the most profound orthoepists in Devonshire slang:—hence the true pronunciation coincides with that of the Gallic noun *ruse*, a stratagem. Two places in the cliff about a quarter of a mile beyond the limekilns which have "rused away" are also termed the First and Second Rusings.

Faults or dislocations breaking through the strata are not of frequent occurrence here; yet we have to notice one, or rather two within a few yards of each other, which may be seen to traverse that part of Salcombe Hill which rises immediately from the Sid. To the same internal expanding forces which threw up the granites of Dartmoor, and which at the same time tilted up the western extremities of the Plutonic and Secondary formations in England, we must refer for an explanation of these appearances.

Fig. 7.



Faults in Salcombe Hill.

The dip of the strata, as elsewhere remarked, descends towards the east; and the line of dislocation, which runs from the top of the hill down to the beach where it is lost, is not perpendicular, but inclines eastward in its passage downwards. The stratification is disturbed and obliterated above, where alluvial deposits, brought down from the more elevated grounds, have been washed over it by rain and other atmospheric causes: but lower down in the face of the cliff, which may here be seventy or eighty feet high, the distortions are seen without difficulty. The most westerly portions, thus divided by the two fissures, are the most elevated, ascending as it were in steps: and allowing that the volcanic eruptions of Dartmoor rent the hill at this point, the effect could not well have been otherwise. This locality is traversed by a white stratum of friable sandstone, such as we have elsewhere observed as being worked by the poorer inhabitants for household purposes: a circumstance which is not at first apparent, as the surface is entirely dyed red by the earth above, which the rains wash over it. It is probable that considerable intervals of time elapsed between the deposition of these strata, that is, the stratum beneath, the white stratum in question, and then the stratum directly above; and that they were precipitated to the bottom of the body of water in which their particles were held in suspension, at separate and distinct operations. First, this is probable, because the line of junction is decided and well defined: and secondly, because an absence of the red oxide in the middle bed, supposes that some great change had been effected in this part of England where this process was going on, by which the colouring matter was removed for a time; and then, that when the superincumbent marl was deposited upon it, another change had taken place, which had restored the colour to its original red.

Through this headland a tunnel was driven a few years ago, for the sake of carrying a temporary railway to the base of Dunscombe Hill, that building stone might be thence transported to Sidmouth with greater facilties than water-carriage was supposed to afford.

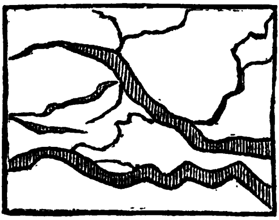
It has already been observed that the New Red Sandstone formation in this country is wanting of the muschelkalk and contains no fossils, with some few exceptions which rather seem to belong to the lias above or to the magnesian limestone below. As we approach the lias at Sidmouth, it might have been supposed that organic remains might have been detected; and besides the more perfect specimens which have been found further on towards Seaton, the cliffs here are not devoid of some indications of a similar nature. Thus, under High Peak Hill, where the softer parts of the soil have yielded to the atmosphere, certain fossil-like remains are seen projecting and exposed, or else have become entirely detached and have fallen to the beach. These, for the most part are cylindrical, and about the size of the finger or smaller, and sometimes they run into ramifications not unlike the branch of a tree. Some discover a radiated appearance on being broken transversely; others do not, but are only of a harder structure than the rock in which they were imbedded; and yet some others have a longitudinal hole through their centre, incrusted with crystals, and now and then filled or partly filled up with a decayed brown woody earth.

Notwithstanding that the upper members of the poikilos series are generally productive of saline springs, we are not aware that any have shewn themselves in this district; but, with the exception of such wells as have been sunk in the lower parts of the town, as on the beach or in the Marsh, the water is of extreme purity. The springs that filtre out of the cliffs near Salcombe Mouth contain much earthy matter in suspension, which they deposit upon whatever substances they run over. Thus we there found a snail-shell completely coated with stone, at first sight having all the appearances of a fossil:

and the "petrified moss" so called, which is little else than this plant similarly covered with the earthy particles which the water deposited during the time that it percolated its fibres, is so far admired as to be often collected for the sake of ornamenting lawns, rockeries, and gardens.

Veins of gypsum are very abundant at the foot of Dunscombe Hill, at that part of the beach which is strewn with masses of sandstone, fallen from the greensand formation above.

Fig. 8.

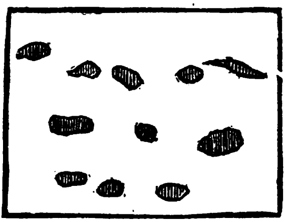


Veins of Gypsum.

The example here given, occupying a length of about six feet, will give an idea of the forms into which they run. Large quantities have from time to time been here collected and calcined, either to be used for casting cornices, mouldings, and similar architectural purposes, or else as a manure for enriching the land. Only such however is collected, as is found on the beach or exposed on the face of the cliff by the wasting away of the surrounding soil: for it would cause too great a waste of land to dig for it and undermine the hill.

Towards the highest beds of the New Red Sandstone, where it directly merges into the Lias, disturbing causes appear to have been in operation which prevented that regularity of stratification or vein-like form observable elsewhere; and hence the gypsum has assumed the shape of nodules, not unlike the nodules of flint distributed in chalk.

Fig. 9.



Nodules of Gypsum.

This diagram is copied from a mass of indurated marl, eighteen inches in its greatest length, the lower half of which was coloured red and the upper half blue, shewing the passage from one formation into the other, as we have remarked, that is, from the red marl into the lias.

The summits of all the high hills in the district lying within the range of our observations, are capped by patches of chert and flints, as already observed, either clear black in hue or opake white, amorphous and angular, imbedded in, and commingled with a tough yellow clay, resting upon the greensand, both in long and extensive beds, and in small and isolated portions, as the shape of the summits of the hills so capped may occasion. As these beds of flint are found incumbent on the greensand in this part of that formation, they are observed, to accompany it even to the detached and very remote places above mentioned; namely, the high land of Haldon, near Exmouth, Newton Bushel, and Bideford: and hence, as De la Beche has remarked, it is probable that nearly the whole of this county was at one time overspread by them. Conglomerated with the tough plastic clay, the flints are found on all the elevations encircling the town which we consider as the nucleus of our observations:--on Dunscombe Hill, lying two miles east, Salcombe and Peak, Cor, Honiton, and Bulverton hills, all rising more or less immediately from the banks of the Sid or its feeders, and on High Peak, a mile and a half west. The conical apex of this last height, composed of greensand and flint beds, is yearly wasting and diminishing, so that "the small greensand cap on the top of it will disappear at no distant date, geologically speaking, and be only known to have existed from the geological maps now constructed of that part of the country." To these cherty patches we owe the nature of the sea beach--a beach made up almost entirely of pebbles more or less rounded by the attrition of the waves, and of the same kind as what is seen above, whence they were brought down by the wearing away of the cliffs. Scattered masses of the lias are also, but sparingly, found at low water; and as quarries of building stone are not met with nearer than Salcombe, these fragments which the tides have transported from beyond Axmouth, are often collected for economical purposes. The pebbly shingle consequently extends along the coast of south-east Devon where the chalk, or the quartzose remains of the chalk, is seen: that is, from Lyme on the Dorsetshire side, to about Ladram Bay: for further on at Budleigh Salterton, its character changes, and the beach is of a different nature. In accounting for the appearances presented on these elevations, we must assume that at one time a perfect stratum of chalk, being the continuation of the great cretaceous formation, extended over this part of the county, even as the greensand is assumed to have done: and that, although no actual white chalk is traceable in these places, yet the flints which accompanied that chalk, being more solid in nature, less destructible, less friable, and not so capable of being washed away by the action of rain, or of sinking into the subjacent soil, have retained their places, whilst the soft carbonate of lime in which they were imbedded, has vanished. In this view of the case, these flints may be considered as the insoluble sediment or *caput mortuum* of the cretaceous series, which has resisted the wasting and transporting action of water and the elements. In the same way, we must likewise extend this hypothesis to the plastic clay, the formation that occupies a place superjacent to the chalk in the ascending order; and which, being of a more argillaceous nature, comparatively insoluble, and more capable of resisting the elements than that which lies beneath it, has settled down upon the flints, and now occupies the original place of the chalk.

In proceeding four or five miles eastward, that is, towards the neighbourhood of Branscombe, we come to the chalk in its more perfect state: and it is here pretty extensively quarried for the sake of converting it into lime, employed both for building and agricultural purposes; and it furnishes a good and fine-grained freestone, advantageously used for architectural mouldings. The summit of Dunscombe hill, still nearer Sidmouth, was at one period worked for similar motives, but these beds are now quarried out and exhausted.

Although this formation in England consists of one homogeneous bed of uniformly white and finely comminuted matter, it is by no means so with some extensive deposits in other parts of Europe--deposits which are apparently of the same geological epoch. This fact is of recent discovery, and has justly called the attention of the learned to it. These new groups range to the southward and eastward of the whiter series, and are made up in a great measure of dark and slaty-coloured limestone. "This difference, [*See Researches in Theoretical Geology. p.* 347,] necessarily points to a modification of origin, so that we should anticipate some circumstances, productive of this white calcareous rock, to have existed over a considerable curved portion of surface, not common to the whole of Europe." After a due consideration of the geological state of this part of the world at the period its formation was going on, the author proceeds by saying--"We can scarcely consider that the white chalk was produced along a line of coast to which nothing but this calcareous matter, mixed with silica, was borne down; since this would suppose a state of things so utterly unlike that at present existing, or which we should imagine ever to have existed, that we seem to be compelled to seek some other explanation for the phenomena observed. The white chalk has more the appearance of a chemical deposit, or rather one resulting from a quick precipitation of carbonate of lime from solution in water, by expelling an excess of carbonic acid which kept the carbonate of lime in solution. If the waters were suddenly heated, a quick precipitation would ensue; and thus we might obtain the carbonate of lime. This is however, not the only condition required. There is an abundance of silica, which, from the mode in which it is deposited, we should infer had been in solution. Now, the abundance of silica which has separated out from the chalk is generally very considerable, so that we require an abundant solution of silica as well as of corbonate of lime. We must also not forget too, that numerous marine creatures lived and swam in the solution, so that, if the mass of chalk were deposited slowly, the conditions necessary for the support of animal life also existed. The question would therefore arise, Has the mass of white chalk been slowly, or somewhat suddenly deposited? Organic remains" he adds "are in general beautifully preserved in chalk: substances of no greater solidity than common sponges retain their forms; delicate shells remain unbroken, fish even are frequently not flattened, and altogether we have appearances which justify us in concluding that, since these organic exuviæ were entombed, they have been protected from the effects of pressure by the consolidation of the rock around them, and that they have been very tranquilly enveloped by exceedingly fine matter, such as we should consider would result from a chemical precipitate. How far the white chalk may have been the result of sudden precipitation, or of a succession of sudden precipitations, it would be difficult to say: but that the carbonate of lime itself fell gently upon the matter beneath it, and speedily became consolidated, seems proved by the conditions of the organic remains found in the chalk."

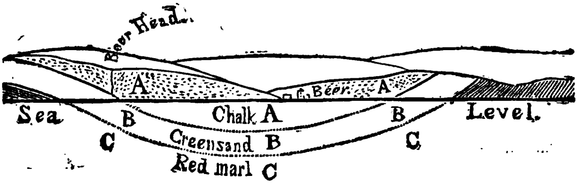
Professor Ehrenberg, a man of much learning and research, has given to this series an animal origin: he is of opinion that all the chalk of Europe is the formation of minute animalcules too small for sight; and he takes some pains to establish this theory, by adducing the results of his experiments and observations. This, however, has been satisfactorily proved by Mr. Lonsdale, and illustrated by Mr. Lyell.

Approaching towards Beer Head, and just after passing the opening of the valley of Branscombe, known as Branscombe Mouth, the red marl somewhat suddenly dips beneath the sea level, being succeeded by the green sand

and chalk: this however is not its last appearance,. for it rises again near Seaton, and continues on to the Landslip, where it again dips down, or is there entirely lost. The depression at Beer Head is remarkable; and has attracted the attention of geologists to that point, in order to account for the observed phenomena.

This will be more clearly understood by a diagram, than by any description, however minute.

Fig. 10.



Section at Beer Head.

In this section the reader may trace the red marl where it dips beneath the sea level on the left or Branscombe side; and he will perceive it ascend again towards Seaton on the right, bearing, superimposed upon it, the stratum of green sand B, and above that again, the chalk A. This depression may have been brought about either by a sinking of the subjacent formations at that place, causing them to fall down, as it were, into a trough; or, there may have previously existed a bason there, into which the superincumbent deposits were drifted at the period of their accumulation. An examination, however, of the seams running through these hills, tends to make the former theory the more probable one.

It is remarkable that terrestrial plants are of rare occurrence imbedded in the cretaceous group —at least of that member to which our observations refer: hence we conclude that dry land covered with vegetation did not exist, or at most to but a small extent in those places where it is found. Had it been so, the productions of that land would probably have found their way into it by the drifting influence of brooks and rivers flowing from the hills into the body of water wherein the carbonate of lime and silica were suspended: sufficient vegetable matter however, was not far distant, as, in several basins, considerable coal fields have been detected.

The silicious particles deposited along with the lime have, after being so deposited, a tendency to aggregate and form nodules: thus, there appears to be such a degree of affinity existing between them towards each other, that by mutual attraction they arrange themselves into those compact masses which we discover in chalk beds, and commonly known by the general name of flints. The origin of flints at one time was a subject of discussion amongst theorists; and indeed, gave occasion to several opposing conjectures and arguments. It often happens, that in the centre of such nodules, we find some extraneous substance or fossil remains, which had doubtlessly served as a nucleus around which the particles of silex congregated; and which formed a starting point where the accumulation began: yet even the most minute examination will often fail to discover such starting point or extraneous matter; and possibly the aggregation was not totally prevented by its nonexistence, but only more rapidly promoted by the presence of such foreign body. Crystallization generally, is also promoted merely by suspending some substance in the crystalizable solution, to give the adjustment of the particles a point from whence to commence arranging themselves into crystallized forms. A fact of similar occurrence, acting on a smaller scale, is mentioned by Mr. Babbage in his work on the Economy of Manufactures; and this is one which, as De la Beche observes, "may be regarded as an experiment highly illustrative of the separation by affinity of extremely comminuted particles of matter, deposited from water which previously held them in mechanical suspension." In describing Mr. Babbage's observations, he goes on to say---"In the common process of preparing the plastic substance for the potteries, flints burnt and ground are suspended with a certain portion of clayey matter in water, and a deposit is produced of the required distribution of the particles of silica among the clay. If the compound be used in proper time, the silicious particles remain disseminated: but if it continue long at rest, the silica becomes aggregated in small lumps, and the mass is rendered useless for the manufacturer."

The above furnishes a beautiful illustration of the formation of flints in chalk. Besides however the horizontal seams in which they are most usually found to run, veins tending diagonally, or more or less perpendicularly to the range of the strata, are sometimes met with: these have the appearance of cross cracks or dislocations filled up with silica, and do not appear to have been very satisfactorily accounted for. Is it not possible to account for them by supposing, that at the time when the chalk stratum wherein they appear was forming and consolidating, fissures might have been made through it, either by a lifting power beneath, or by its own contraction in settling and perhaps cooling, and that these fissures so made and then open, may have served as receptacles to the silicious matter, which in its fresh and unconsolidated state, may have oozed from the carbonate of lime into them, and then the whole mass afterwards have become indurated together? If such were the case, a cross section would present appearances which may be compared to those exhibited in Babbicombe, Chudleigh, and other limestones, where former cracks and dislocations running through the stone, have become filled with crystallized carbonate of lime or stalactite, once filtered into them in the same way as we have above supposed the liquid silica may have run, as into a mould, into the cracks in the chalk stratum. This hypothesis is merely advanced on supposition and analogy, for the consideration of the geological reader.

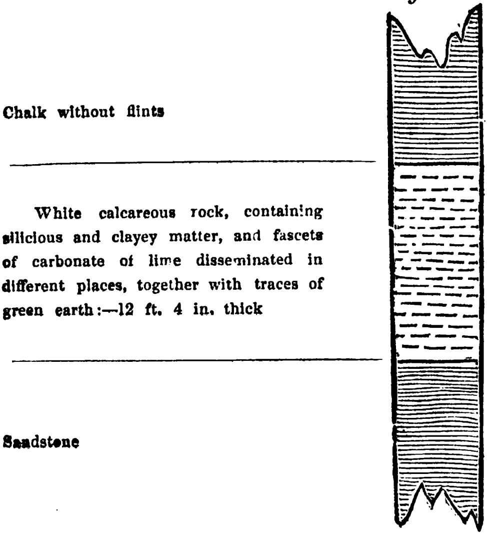
We have already observed that the Sidmouth hills, being composed of red marl, although serviceable for the manufacture of bricks, yield no quarries of stone, the nearest being in the neighbourhood of Salcombe, where we arrive at the commencement of the greensand formation: and here, the declivity of a hill near the church has been opened for that purpose. Further on towards Beer, an excellent, fine-grained, and white freestone is obtained in the outlyers of the chalk near that place: and the authority from which we have before quoted speaks of it in the following words:—"At Beer," it says, "in Devonshire, we find the lower part of the chalk, or the upper part of the greensand, for the beds may be said to occur at the passage of the one into the other, worked for building stone. It is nearly white, and chiefly composed of carbonate of lime, with the addition of some argillaceous and silicious matter, and a few scattered particles of green silicate of iron. When first quarried, this stone is, as is generally the case with similar materials, somewhat soft and easily worked, from the presence of the water disseminated through the stone, becoming hard when this water has been evaporated by exposure. The chief quarry is subterraneous, and extends into the hill about 180 yards, the roof being supported by large square pillars formed by portions of the workable beds left standing. The following eight beds are worked beneath about eighteen feet of indurated chalk without flints, termed *skull*:--

		Ft.	In.
1.	Upper bed:--rather hard	1	6
2.	Soft	1	6
3.	Rather soft	2	0
4.	Rather soft	2	0
5.	Hard	1	4
6.	Mixture of hard and soft	1	4
7.	Very hard	0	8
8.	Very hard	2	0
		12	4

"A shaft was formerly sunk, and a level driven into the hill, between Beer Head and Branscombe, in order to obtain a continuation of the same beds; but the work does not appear to have been profitable, as it is now abandoned."

The subjoined is a section of the quarries at Beer Head:—

Fig. 11.

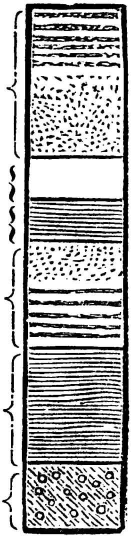

Chalk without flints
White calcareous rock, containing silicious and clayey matter, and fascets of carbonate of lime disseminated in different places, together with traces of green earth:—12 ft. 4 in. thick
Sandstone

The organic remains found in this district in the sands beneath the chalk, according to Dr. Fitton, are the following:—*Thetis major*, *Inoceramus sulcatus*, a new *Pecten*, *Ostrea* *macroptera, Gryphæa vesiculosa, Ezogyra lævigata,* and *Conica.*

Sidmouth beach has been long and justly celebrated for the beautiful and even precious stones which have, and now are, from time to time picked up by the water side. The chalk and greensand contain many sweetly coloured pieces of flint and chalcedony, whence those found on the beach come, by the washing down of the cliffs, and which may be cut and turned into various handsome articles of jewellery, such as snuff-boxes, seals, ear-rings, &c. "Portions of this mineral," says De la Beche, "when worked into seals cannot be distinguished from the finest white cornelian, which in fact, they then are. Both such flints and chalcedony are found on the coast between Lyme Regis and Sidmouth, where also are discovered some varieties of jasper (from the greensand) many specimens of which closely resemble the Egyptian pebbles, and indeed are quite as beautiful." Precious stones however, such as jasper, agate, Egyptian pebbles, or cornelian, are the minor riches of Devonshire, according to the chronicles of one or two old writers on the productions of this county; since at one time there existed profitable silver mines in the neighbourhood of Combe Martin. We are told that William de Wymundham accounted at the treasury for 270 pounds weight of silver raised in Devonshire. We fear these mines have been worked out and exhausted since then.

The following is a perpendicular section of the hills near the Landslip, and immediately on the eastern bank of the river Axe:—

Fig. 12.



Chalk, with flints in layers in the upper part, but distributed promiscuously towards the lower half. Thickness about 100 feet.

Chalk without flints. 35 feet.

Chalk mixed with grains of quartz. 25 feet.

Yellow Sandstone, containing seams of chert: also traces of chalcedony, oxide of iron, and broken shells. 75 feet.

Fox-mould. 75 feet.

Green sand:—This contains numerous organic remains: nodules termed *Cowstones*, mixed up with green earth, silicate of iron, and silex grains. 45 feet.

Slight mention has already been made of the Haldon hills when treating of the features presented by them, and the fact of their being overlaid by isolated patches of greensand and flints, in common with the summits of most of the similar detached ranges scattered throughout Devonshire, though more particularly on the Dorsetshire side. The subjoined section of Little Haldon, taken through a hill lying on the west of Sidmouth, beyond the river Exe, at about the same distance as the above section near the Landslip, is considered not out of place here, as furnishing the reader with a comparison of the strata in the two sides of the district which have more particularly come under consideration:—

		Ft.	In.
1.	Small flints	4	0
2.	Brown sand	10	0
3.	Flints (chert?) large size .	8	0
4.	White sand, used for making stucco	11	0
5.	Red sand	1	0
6.	Fine-grained, dark-coloured sand .	14	0
7.	Green sand	9	0
8.	Large flints (chert?) mixed with light-coloured sand	13	0
9.	Fine brown sand	15	0
10.	Red sand	4	0
11.	Pipe clay—very white . .	1	0
12.	Rounded gravel, like brook or river gravel	1	6
13.	Red rock	4	0
		95	6

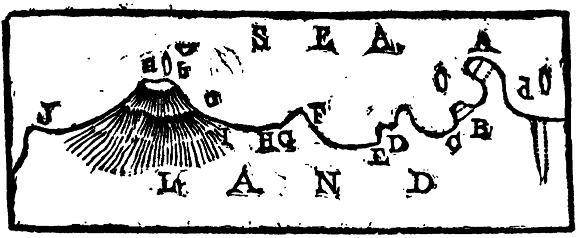
Next above the New Red Sandstone we come to the Lias in taking the general gradation of the stratified beds of soil in the upward order of succession; but as this formation does not become well developed until we enter the county of Dorset, fifteen miles east of Sidmouth, and rather beyond our limits, it is held unnecessary to devote any time to it. It is true, the cliffs between Lyme and the Landslip, present portions here and there laid bare, and even at Beer Head, there are indications of it between the chalk and the variegated marls, but these outlyers do not warrant our detaining the reader. If however, he is desirous of studying the numerous and interesting fossils contained in this series, he will, in De la Beche's Geology of Cornwall, Devon, and Western Somerset, find a list of 120 different species of plants, corals, radiaria, annulata, chonchifera, mollusca, crustacea, fish, sauroids or lizards, and reptiles, which have from time to time been taken from the cliffs near Lyme. Lias is composed of calcareous and argillaceous deposits succeeded as we further ascend, by the inferior and great Oolite. It is so regular in its arrangement, that a section in one place will exhibit almost precisely the same face as any other section taken elsewhere; and there are few situations where it can be better observed and studied than along the sea shore between the Pinhay Cliffs and Bridport.

Besides the list above mentioned, the gravels of Charmouth and its neighbourhood contain the remains of the rhinoceros, bear, hyæna, and some others; in the search for which, the practical geologist is well and abundantly rewarded in the vicinity of that place. The Lias is of a cold and sterile nature, as compared with the red marl: and the superior fertility of the valley of Sidmouth, although open to the north, over the valley of Lyme, notwithstanding its sheltered position, will be apparent to every one on looking at the two: and this fact is further proved by the produce of the land both in the garden and in the field.

Any one travelling through a new district, may obtain a tolerably correct knowledge of the geology of that district by taking note of the materials with which the poorer class of houses are built—not the mansions of the rich, for they are sometimes constructed of materials brought from a distance,—but the cottages and poorer houses, for they it is that are made of whatever is the most readily found on the spot. Thus, as there are no stone quarries in the immediate vicinity of Sidmouth, the ordinary run of buildings have been put together with the red brick made of the clay abounding in the neighbourhood, or else of what is locally termed "cob;" i. e. marl wetted with a due proportion of water, mixed with straw, and sometimes a small quantity of lime to make it harden. More costly, or more substantial structures are not infrequently composed of the masses of blue lias collected on the beach, which have been driven by the tides from the lias formation beyond the river Axe: but the two churches are almost entirely built of a silicious sandstone procured at Salcombe. The best lime for these purposes is brought from Babbicombe by water and calcined at Sidmouth: lime made from the lias is also used, especially for subaqueous works, where it is required to set quickly. An inferior quality, and therefore mostly devoted to agricultural uses, is burnt from the chalk rocks of Branscombe and Dunscombe.

The general features of the coast are always on the change, owing to the destruction which the elements above and the waves beneath are unceasingly making on the cliffs. Although the change goes on gradually, and although such as are in the habit of looking at them every day, are not aware of this destruction, except on certain occasions when a wet season will cause masses of many tons' weight to come down suddenly with the noise and concussion of an earthquake, still, the interval of a few years, or a short absence from the spot, and then a return to the same scene, shews a decided alteration in the outlines of most of the sea-fronting precipices. The Natural Arch at Ladram Bay is a beautiful illustration of the excavating power of the waves in this neighbourhood: and a visit to it should never be omitted, whether by the geologist or by the lover of the picturesque.

Fig. 13.



Plan of the coast between High Peak Hill and Ladram Bay.

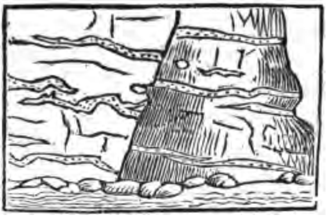
a, High Peak Hill. b, Picket Rock. c, Sandy Cove. d, Ladram Bay.

The diagram *Fig.* 13, will give an idea of the line of coast between Ladram Bay and High Peak. The letter A shews the site of the Arch which has been celebrated for a long time in this neighbourhood, and B points out a second arch which has been excavated during the last fifteen years. At C, a fault or dislocation of the strata is examined from the beach at low water without any difficulty, for the cliff being bare and perpendicular, no obstruction is offered to the researches of the geologist. It may be about sixty or seventy feet from the sea shore to the fields above, somewhat rapidly ascending from the Arch towards the summit of High Peak. Never having taken minute admeasurements of the Arch at A, we cannot with certainty inform the reader hereon; but its extreme irregularity of figure would render it next to impossible to lay its precise dimensions down in numbers. If the cliff be seventy feet high from the sand at low tide to the base of the flag staff, (which is probably near the truth,) the greatest perpendicular, to where the key-stone would be, may measure thirty feet or more; and the greatest average horizontal opening, or span, may extend to about forty. The axis is not far from the meridian of north and south. It is only at the time of dead low water, and not always then, except at spring tides, that a pedestrian can pass through with dry feet, either when approaching it in the direction from Sidmouth or from Ladram Bay. To avoid disappointment, the best plan is to walk to Ladram over the hills, so calculating the time as to arrive there at the moment when the water is lowest; then go through it, and return to Sidmouth along the beach, when the sea-faces of the cliffs can be examined all the way. The second and more recent one is not so large nor so cycloidal in curve; but its outline, owing to the softness of the rock, will always be subject to change.

Faults also occur at D, E, G, H, I, and J, as well as at C, as we have mentioned.

The base of High Peak Hill in this district appears to have been rent and injected with hot volcanic matter, since the veins which may be seen passing between the strata, resemble the amygdaloid of Northernhay at Exeter. Vast masses of this lava cover the beach, where, owing to its extreme hardness, it has been better able to resist the action of the waves, than the sandstone in which it was imbedded. At F it may be seen passing into the new red formation very clearly; and in various other places on both sides of Picket Rock, the veins basset out on the exposed escarpment of the hill. These veins at J, (as shewn in *Figs.* 13 and 14,) have been dislocated by a fault subsequently to their injection.

Fig. 14.



Volcanic veins in High Peak Hill divided by a fault.

Round stones and boulders are discernible at this point, which had previously been subject to the attrition of water.

In some places the water has effected hollows and caves as at Ladram and elsewhere; whilst at others, where the rock has proved of a harder nature than the soil of the rest of the hill, large detached tower-like masses are left standing by themselves in the sea, all the more yielding earth having been removed from behind them. Thus there are many such towers of rock along the coast between Sidmouth and Otterton Point, four miles westward. "The Two-penny Loaf" so called by the fishermen, lies at about three miles in this direction, and is a useful land-mark to them in their fishing excursions. Several masses of a similar kind, but of much larger dimensions, are also to be seen in Ladram Bay near the Arch, and two more at Picket Rock (query, *Peak-ed* Rock? pronounced in two syllables) lying off the base of High Peak Hill. These last are well seen from Sidmouth, and the tallest, or that which is nearest the shore, in contour somewhat resembles the human bust and profile. On the beach near Picket Rock Cove a vast quantity of round hard stones may be observed of a dark brown colour and great weight for their size. They vary from the bigness of a large walnut down to that of a pea, and as perfectly globular as a musket ball. They contain much iron, and on being broken with a hammer, exhibit a glittering and semi-crystalline appearance with lines running in radii from the centre. These have by some persons been mistaken for aerolites or meteoric stones; whereas they are nothing but nodules where the irony matter impregnating the red composition of the hills, as before observed when speaking more particularly of the origin of the New Red Sandstone, has collected towards one point, probably in the same manner as the silicious particles in the chalk collect and form flints.

Chit Rock, as heretofore said, was destroyed in the night between the 22nd. and 23rd. of November 1824, by a storm which did great damage over an extensive area in Northern Europe. On this occasion the violence of the south-westerly gale of wind that blew at the time, rose the sea to an extraordinary height and carried it over the walk which runs on a ridge or somewhat elevated embankment in front of the town. The substantial sea-wall which now protects this Walk, not then having been built, left the waves free passage, so that the earthwork of the embankment yielded before their impetuosity, and opened a way for the water into the the town. The result was, that they